

Appln. No. 10/502,109

Attorney Docket No. 10555-46

II. Remarks

Claims 1-7 and 10-15 stand rejected. Claim 1 is being amended. Accordingly, after entering this amendment, claims 1-19 remain pending.

As amended, claim 1 recites a photodiode with a semi-insulating substrate layer, a first p-type semiconductor layer, an n-type semiconductor layer, and a second p-type semiconductor layer disposed between the first p-type semiconductor layer and the n-type semiconductor layer such that the second p-type semiconductor is directly adjacent to the n-type semiconductor. The second p-type semiconductor layer has a graded doping concentration along the path of carriers.

Reconsideration and re-examination of this application in view of the above amendments and the following remarks is herein respectfully requested.

Allowable Subject Matter

The undersigned acknowledges the Examiner's indication of the allowability of claims 8, 9, and 16-19.

Claim Rejections - 35 U.S.C. §102(b)

Claims 1-3 have been rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,581,087 to Uddin, et al. ("Uddin"). Claims 1-3, 7 and 10-12 have been rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,016,073 to Elliott, et al. ("Elliott"). Applicants respectfully traverses these rejections.

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Turning to the references, Uddin does not teach a photodiode with a "semi-insulating substrate layer," as now recited in the amended claim 1 (see, e.g., Fig. 1 of Uddin and compare with Fig. 2 of the present application). Rather, Uddin teaches a photodiode having "a first α -SiC layer 11 of p-type, epitaxially formed on an α -SiC substrate 10 of p^+ -type α -SiC." (Column 4, lines 4-6; emphasis added; see also Uddin's Abstract stating that the "radiation detector includes a photodiode composed of an α -SiC substrate of a first conductivity type" Emphasis added.)

Regarding Elliott, that reference does not teach a photodiode with a "semi-insulating substrate layer," as described in amended claim 1 (see, e.g., Fig. 1 of Elliott and compare with Fig. 2 of the present application). Additionally, the p-type layer (region 12 of Fig. 1) in Elliot's photodiode is "arranged to be sufficiently long" with "at least three minority carrier diffusion lengths, or *in excess of* $\sim 150 \mu\text{m}$ " (Column 4, lines 8-14; emphasis added.) There is a strong inference, therefore, that this p-type layer taught by Elliott is a p-type substrate because it is well-known in the art that epitaxially deposited layers are generally less than a few microns in thickness.

Further, Elliott does not teach a "second *p*-type semiconductor layer having a *graded doping* concentration," as stated in amended claim 1. The p^+ region (14) shown in Fig. 1 of Elliott with a "doping level ... sufficiently low to produce *near intrinsic* characteristics" (column 3, lines 66-68) is not a "*p*-type semiconductor," as required by claim 1.

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Even if this p^- region can be viewed as a p-type semiconductor, Elliott does not teach a "graded doping concentration along the path of carriers" in their p^- region, as recited in amended claim 1. Elliott states, at column 4, lines 15-18, that the "alloy composition and doping level of region 14 [p^- layer] changes gradually to those of region 16 [n layer] over a distance of several hundred Angstroms to avoid the creation of a pronounced electronic barrier," which teaches away from a "second p-type semiconductor layer having a graded doping concentration along the path of carriers." Specifically, Fig. 2 of Elliott shows a lack of "graded doping" in the p^- region "along the path of carriers" as illustrated by the flat valence band 32 at zero bias throughout most of the p^- region. As taught by Elliott, the "gradual change in the compositions and doping levels of regions 14 and 16" (column 4, lines 37-39) is limited to only "several hundred Angstroms to avoid the creation of a pronounced electronic barrier" (column 4, lines 15-18) and not extended to the entire p^- region, which is along the path of the carriers.

Moreover, Elliott does not teach "providing a substrate layer," as recited in claim 10. Specifically, a substrate layer is not shown in Elliott's Fig. 1, and Elliott does not describe "providing a substrate layer" anywhere in the patent disclosure.

In sum, neither Uddin nor Elliott teaches a photodetector with a "semi-insulating substrate layer" and a "second p-type semiconductor layer having a graded doping concentration along the path of carriers," as recited in amended claim 1, and Elliott further does not teach "providing a substrate layer" or "grading



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of the p-type dopant of the second p-type semiconductor layer from a first concentration to a second concentration," as required by claim 10.

Since neither Uddin nor Elliot teaches each and every element of amended claim 1, and Elliot does not teach each and every element of claim 10, reconsideration of the rejections under 35 U.S.C. §102(b) and the allowance of claims 1 and 10 are respectfully requested. Further, since claims 2-3, 7, and 11-12 depend, directly or indirectly, from claims 1 or 10, the reasons for allowance of claims 1 and 10 apply as well to the dependent claims.

Claim Rejections - 35 U.S.C. §103(a)

Claims 4-6 and 13-15 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Saito. Applicants respectfully traverse this rejection.

Saito uses a non-single-crystal material to achieve "graded band gap diode", which would be inoperative if the single-crystal semiconductor layers of InAlAs, as required by claims 4, 5, 13, and 14, and InGaAs, as required by claims 6 and 15, were employed in place of the SiGe non-single-crystal layers. Furthermore, Saito teaches away from Applicant's photodiode, since Saito states, at column 1, lines 46-50, that "it is commonly recognized that it is difficult to make a *single crystal film* ... since the grading constants of Si and Ge are different from each other" (emphasis added).

Accordingly, Saito cannot render claims 4-6 and 13-15 as obvious. The rejection under U.S.C. §103(a) is therefore improper and should be withdrawn.



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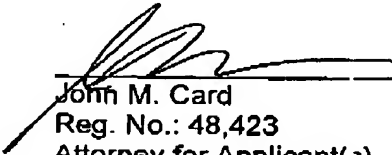
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Conclusion

In view of the above amendments and remarks, it is respectfully submitted that the present form of the claims (claims 1-19) are patentably distinguishable over the art of record and that this application is now in condition for allowance. Such action is respectfully requested.

Respectfully submitted by,

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